NanoTech

Midatech Ltd deals on gold technology

Midatech Ltd, a world leader in the design, synthesis and manufacture of biocompatible nanoparticles has signed a license agreement with the Universidad Computense de Madrid and the Materials Science Institute of Seville giving it new leeway to exploit the therapeutic potential of gold nanoparticles. The exclusive worldwide license opens up a range of possible applications for nanoparticles with a gold core, from localized drug release to cell apoptosis achieved through radiofrequency heating technology

Gold nanoparticles improve HIV drug

Chemists at North Carolina State University have discovered that adding gold nanoparticles to a failed HIV drug regenerates the drug's ability to stop the virus from invading the body's immune system. The drug, a compound known as TAK-779, was originally found to bind to a specific location on human T-cells, which blocks the HIV virus' entry to the body's immune system. Unfortunately, the portion of the drug's molecule (an ammonium salt) that made binding possible had unpleasant side effects. However, gold nanoparticles, offer the perfect "scaffold" to attach molecules of the drug to in the absence of the ammonium salt, holding the drug molecules together and concentrating their effect. The researchers found that attaching 12 molecules of SDC-1721, in the modified drug, to one nanoparticle of gold restored the drug's ability to prevent HIV infection in primary cultured patient cells.

J. AM. CHEM. SOC. 2008, *130*, 6896–6897

WORLD GOLD COUNCIL

GOLD news

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NSTI Nanotech
The Nanotechnology Conference and Trade Show

At the recent NSTI Nanotech 2008 event, World Gold Council was pleased to be exhibiting with a range of organisations that are commercialising technologies exploiting gold's unique properties at the nanoscale.

The technologies displayed included new gold nanoparticle formulations capable of producing a decorative shiny gold print on paper at room temperature.

Decorative text in gold directly printed at room temperature by Johnson Matthey

Also on the WGC stand, the University of Victoria, Wellington, New Zealand displayed a proprietary nanotechnology concerned with the use of gold nanoparticles as stable colourants on fabrics and textiles, particularly merino wool for high quality fashion garments and other applications. Gold nanoparticle colourants have the advantage that they cannot fade or denature in light, as traditional organic dyes can. The university's technology is concerned with the preparation and incorporation of gold nanoparticles of different sizes and hence different colours, into wool and other natural and synthetic fibres and substrates, by the controlled reduction of the gold ion to metallic gold nanoparticles onto and within the fibre or substrate.

For more information on these and other gold related nanotechnologies displayed at Nanotech2008 please see http://www.utilisegold.com/uses_applications/nanotechnology/

Cotton fabric (above) and cotton and merino wool yarn (below) coloured with gold nanoparticles

In vivo tumor targeting and detection by gold nanoparticles

Biocompatible and nontoxic metal colloidals for *in vivo* tumor targeting and detection based on gold nanoparticles and surface-enhanced Raman scattering has been reported in the journal *Nature Biotechnology* (26, 2007, **83-90**). The researcher attached positively charged organic dye molecules to the gold nanoparticle surface. The dye molecules absorb and emit light in the near-infrared region. A nanometer-thick layer of polyethylene glycol (PEG) was added to the dye functionalized gold particles to make them biocompatible. The optical properties of both the gold nanoparticles and the dye molecules remained constant even after application of the PEG coating. These particles were also nontoxic to cells over periods as long as 6 days. These initial experiments showed that the coated gold nanoparticles could serve as potent imaging agents for studies of cancer cells, but the real goal of this project was to develop targeted *in vivo* imaging agents for detecting cancer in humans.

To prepare a targeted nanoparticle, the researchers used PEG coated dye functionalized gold particles to which they could chemically link an antibody that binds to epidermal growth factor receptor (EGFR), a molecule over-expressed on many types of tumors.

The investigators injected the targeted nanoparticles into mice with EGFR-positive human head and neck carcinomas and obtained SERS spectra 5 hours later. As control experiments, the researchers injected matching mice with the untargeted nanoparticle.

The unique optical spectra of the nanoparticles were easily detected in both sets of animals, but only the targeted nanoparticles accumulated in tumors. In contrast, the untargeted nanoparticles accumulated largely in the liver. For further information, please contact: Shuming Nie, at the Departments of Biomedical Engineering and Chemistry, Emory University and Georgia Institute of Technology and Winship Cancer Institute, Emory University School of Medicine.

E-mail: snie@emory.edu

Gold nanocomposites for cancer detection

A group of Korean researchers have reported on the use of gold nanoparticles for epithelial cancer detection and therapy through magnetic resonance imaging techniques. The composite system consists of the nanocrystals of magnetic kernels ($MnFe_2O_4$) encapsulated by ethylene glycol. Erbitux, a therapeutic antibody, was conjugated with the hybrid system.

See Jaewon Lee et al, 2008 *Advanced Functional Materials* **18**, 258–264

Gold nanoparticles for rapid and efficient identification of *'E. coli'* bacteria

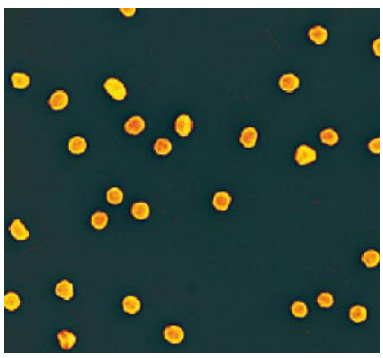
The integration of gold nanoparticles with conjugated fluorescent polymers has provided a powerful bio-diagnostic tool to identify different strains of *E. coli* bacteria. Researchers from Georgia Institute of Technology and the University of Massachusetts tested the efficacy of the method by using different species, as well as the different strains of a single species of *E. coli* bacteria without the use of antibodies or radioactive markers.

See R. L. Phillips et al, *Angew. Chem. Int. Ed.*, DOI: 10.1002/anie.200703369 for more information

Standard gold nanoparticles for bio-nanotech research

The National Institute of Standards and Technology (NIST) has issued its first reference standards for nanoscale particles targeted at the biomedical research community. The three new materials (gold of nominally 10, 30 and 60 nanometers in diameter) were developed in cooperation with the Nanotechnology Characterization Laboratory (NCL) of the National Cancer Institute (NCI). The NIST reference materials are citrate-stabilized nanosized gold particles in water. They have been extensively analyzed by NIST scientists to assess particle size and size distribution by multiple techniques. Dimensions were measured using atomic force microscopy, transmission electron microscopy, scanning electron microscopy, differential mobility analysis, dynamic light scattering and small-angle X-ray scattering. In addition to average size and size distributions, the new materials have been chemically analyzed for the concentrations of gold, chloride ion, sodium and citrate, as well as pH, electrical conductivity and zeta potential. They have been sterilized with gamma radiation.

Further information contact Michael Baum: michael.baum@nist.gov

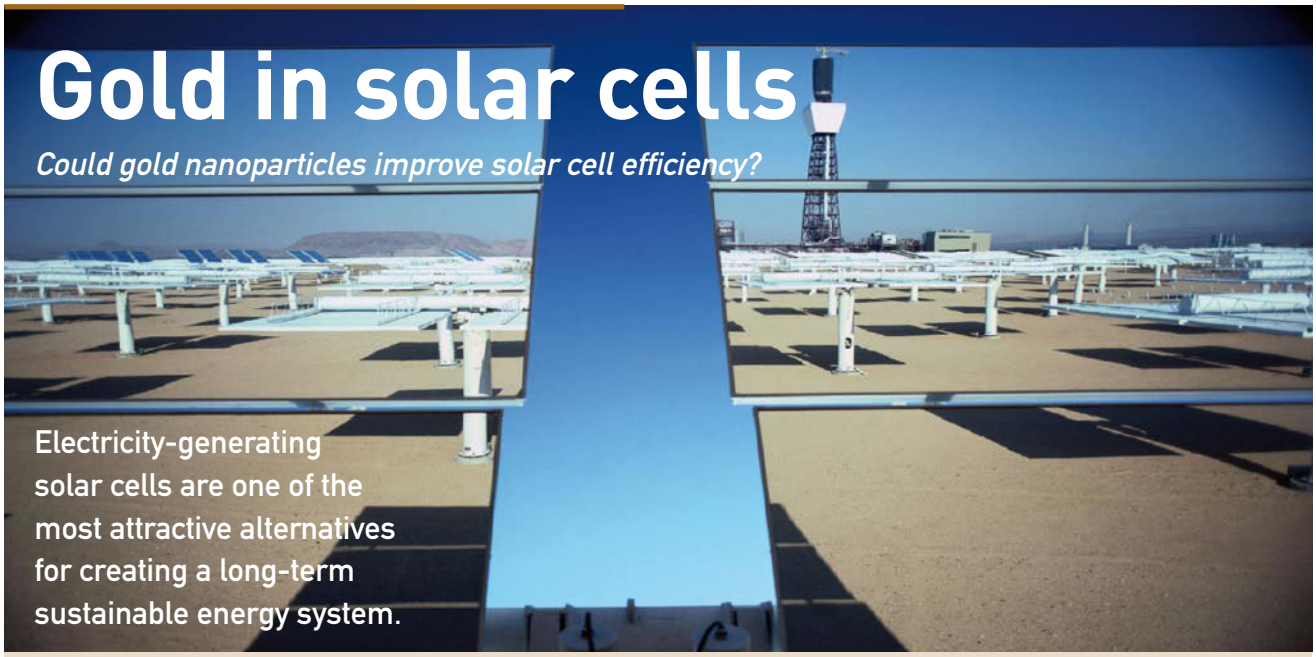


False color scanning electron micrograph (250,000 times magnification) showing the gold nanoparticles created by NIST and the National Cancer Institute's Nanotechnology Characterization Laboratory (NCL) for use as reference standards in biomedical research laboratories.

Credit: Andras Vladar, NIST

Gold in solar cells

Could gold nanoparticles improve solar cell efficiency?



Electricity-generating solar cells are one of the most attractive alternatives for creating a long-term sustainable energy system.

Researchers are now looking at how nanotechnology can contribute in bringing down the cost and improve the performance of the system. One way to enhance the absorption of the solar harvesting material in a solar cell is to make use of nanoparticles of gold. Carl Hägglund at Chalmers University in Sweden has looked at how this can be done in his recently completed doctoral dissertation. The experimental and theoretical results show that the particles can help transmit the light's energy to useful electricity in several different ways. For more information, please contact Carl Hägglund, Chemical Physics, Department of Applied Physics, Chalmers University of Technology.
E-mail: carl.hagglund@chalmers.se

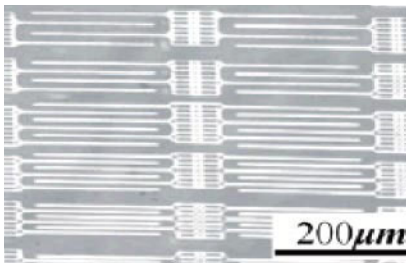
References:
C. Hägglund, M. Zäch, B. Kasemo, *Applied Physics Letters* 92, 013113 (2008).
C. Hägglund, M. Zäch, G. Petersson, B. Kasemo, *Applied Physics Letters* 92, 053110 (2008)

Direct nanoimprinting of gold nanoparticles on polyimide substrate

Hexanethiol encapsulated 2–3 nm sized gold nanoparticles were used to fabricate micro/nanoscale metallic structures on flexible polymer substrate by a direct nano-imprinting technique for high resolution flexible electronics fabrication. Various microstructures of gold such as microwires, microholes, and microdots were fabricated with no or negligible residual layer between the nanoimprinted features. Nanoscale structures such as gold nanowires, nanodots, and arbitrary designs with minimum feature size of 75 nm have also been successfully fabricated by this nanoimprinting technique.

The direct nanoimprinting approach on a flexible polymer substrate using encapsulated gold nanoparticles was developed by scientists from University of California, Berkeley and Korea Institute of Machinery and Material. It is expected that a low-cost, high throughput and high resolution process may result from this work.

Photo of electrical devices nanoimprinted on polyimide substrate



Optical micrograph of micro-scale electrical structures on a polyimide substrate fabricated by direct nanoimprinting of gold nanoparticle solution

Park, et al, *Advanced Materials* 20 (2008) 489–496
For further information, please contact:
Prof. C. P. Grigoropoulos and Prof. A. P. Pisano,
Department of Mechanical Engineering
University of California, Berkeley, USA.
E-mail: cgrigoro@me.berkeley.edu; appisano@me.berkeley.edu